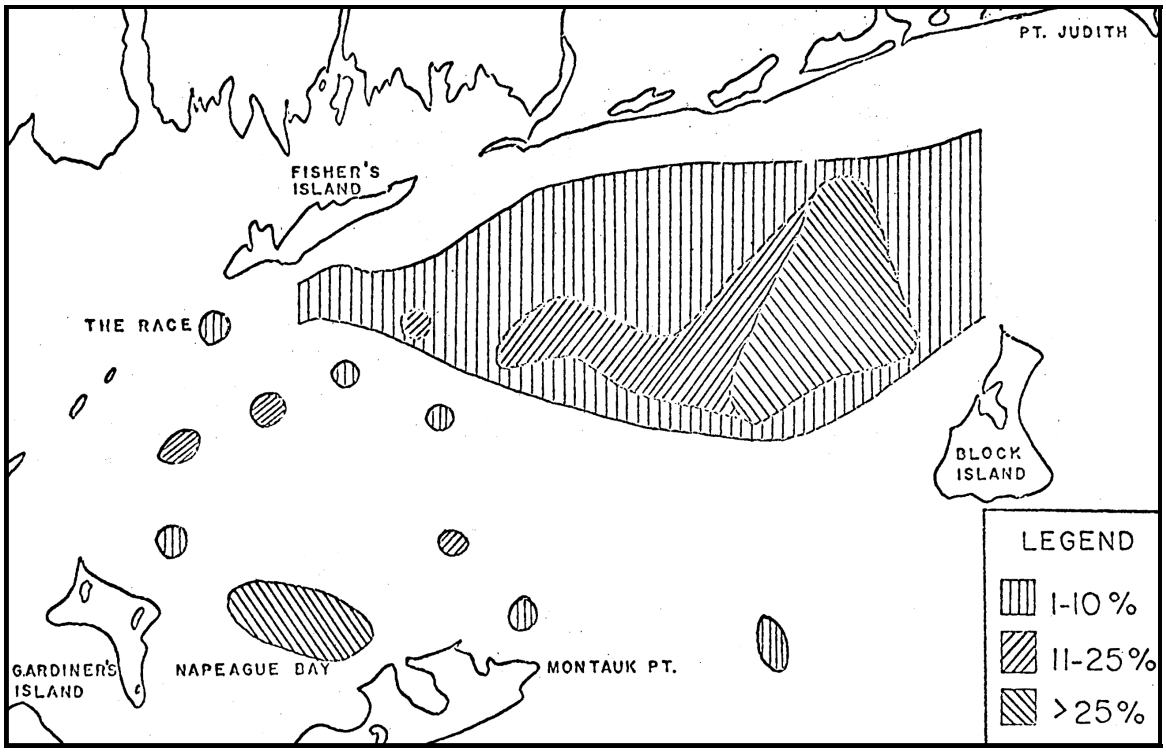

Figure 7. Percentages of silt found in bottom sediments (from Savard, 1966).

Yokubaitus (1977) corroborated these results with side scan sonar surveys of Block Island Sound. East-central Block Island Sound was described as a flat, featureless plain of silty sand, largely inactive due to the absence of discernible bedforms. This report suggests that sand may be deposited in this region during storms, based on evidence of sand/silt lamination in vibracores obtained in the area (Dignes, 1976). Other vibracores obtained in this region (Twitchell, 2001) also document an approximate 8 foot layer of silt over coarse sand, suggesting some historical event or process may be responsible for deposition of larger-grained sediments in this area.

Analysis of Block Island Sound Monitoring Locations

Two locations within Block Island Sound were designated for detailed monitoring to assess suitability for dredge material disposal. This section provides a closer look at the bathymetry, bottom sediment types, and physical processes at these designated locations.

One monitoring site (Site 8) is located about two nautical miles south of East Point, Fishers Island, and the other (Site 9) approximately 4 nautical miles southeast of Watch Hill Point, Rhode Island. Coordinates and water depths of the sites are:

Site	Latitude	Longitude	Depth (feet)
8	41° 15.0' N	71° 55.7' W	170
9	41° 14.8' N	71° 48.4' W	100

The bathymetry in the vicinity of Site 8 is variable owing to its proximity to The Race and Fishers Island. A relatively broad trough runs approximately east-west along the southern shore of Fishers Island, and appears to be a tidal transport pathway from The Race to the passage between Block Island and Rhode Island Sounds. Depths in this broad trough are approximately 120-140 feet, more variable near The Race and less variable to the east. There appear to be several kettle hole depressions in this region, similar to kettle ponds found on the mainland, where depths can reach over 300 feet. Site 8 appears to be on the southern fringe of one these kettle holes, in which the maximum depth is 241 feet (NOAA chart #13205).

Site 9 lies about 5½ nautical miles east of Site 8. This site resides on the southern fringe of the east-west tidal pathway between The Race and Rhode Island Sound, and on the northern edge of the Sound's central plain. Bathymetric gradients in this area are mild, with site 9 located in a plain of relatively constant depth (100-110 feet).

Currents at both these locations are tidal, situated in the major transport corridor between The Race and Rhode Island Sound. Williams (1969a) reported brief observations in these regions, Station A, lying approximately 0.7 nautical miles west of Site 8, and Station 21, lying about 1.5 nautical miles south-southwest of Site 9. Mid-depth currents at Station A were of order 1.5 knots on the ebb and 1.4 knots on the flood; directions were east-west. Station 28 (closer to Fishers Island) showed bottom currents (2.0 knots) were slightly less than mid-depth currents (2.2 knots), suggesting bottom currents at Site 8 may be approximately 1.0-1.5 knots. Near-surface currents at Station 21 were 1.0-1.2 knots, and were also directed east-west.

LeLacheur and Sammons (1932) reported current observations obtained at individual stations within Block Island Sound in August 1930. One station, approximately 1-2 nautical miles south of Site 8, had bottom currents approximately 1.3 knots during peak flood and 1.5 knots during peak ebb tide. Surface currents at the same time were of order 1-2 knots. Flood flow was oriented west-southwest (261°) and ebb flow towards 94° (or east). These measurements were repeated two weeks later, with bottom flows reported 1.3 knots during peak flood and 1.0 knots during peak ebb. Directions were similar. These observations should be used in a qualitative manner, as they were obtained about '2-1/4 miles north-northwest of Cerberus Shoal', or about 2 nautical miles west of site 8, probably too close to The Race for meaningful extrapolation. However, these measurements are considered useful to this study to illustrate the tidal asymmetry, vertical variation of currents, as well as the large deviations between the fortnightly observations.

Another station located in the central part of Block Island Sound was sampled in a similar manner (LeLacheur and Sammons, 1932). This location was described only as 'Mid-Sound, south of Watch Hill', and by the map provided it is assumed this location is

near site 9. Current profiles were reported of similar magnitude to those at stations to the west (Figure 8), with flood flow directed west-southwest (257°) and ebb flow towards east-southeast (97°).

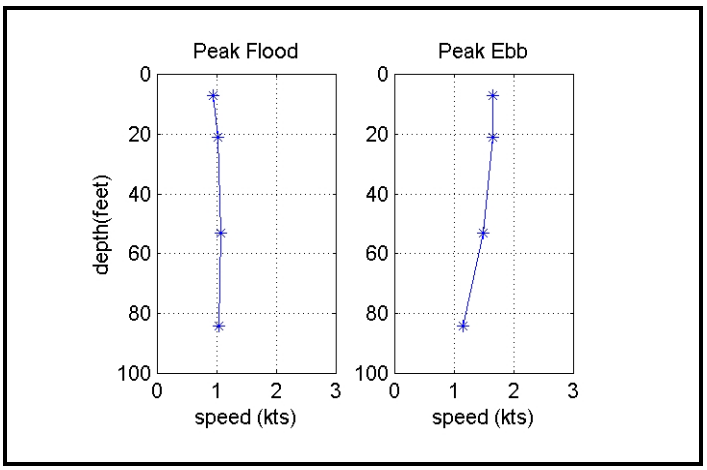

Figure 8. Current profiles obtained in 'Mid-Sound, south of Watch Hill' (LeLacheur and Sammons, 1932). These profiles were obtained in August, 1930 and represent average values over a 1-½ day period.

These observations are relatively consistent, suggesting peak bottom current speeds about 1.0-1.5 knots near Site 8, and milder bottom currents at Site 9. However, exact locations of these observations are difficult to interpret from the literature and thus some uncertainty exists, especially since there is evidence of strong topographic control on current behavior. The variable bathymetry in the vicinity of kettle holes or near the moraine (for example Fishers Island) will modify the currents, and possibly create significant spatial variations. Currents are likely more complex near Site 8 than at Site 9, which is in a region of less variable bathymetry.

Bottom sediments at site 8 are comprised primarily of sand (Figure 9) with areas of silt to the west near site 9 (Savard, 1966). These sediment types can indicate intensity of bottom currents, suggesting site 9 lies in an area of weaker bottom currents. Surficial sediment samples obtained by Savard (1966) near Site 8 (approximately 0.4-1.0 nautical miles away) indicate sediments comprised primarily of sand, with some gravel and silt. Many of these samples were obtained on higher ground within the broad trough area, not within the kettle holes. These sediment compositions indicate bottom currents may be above 0.27-0.37 cm/sec (0.52-0.72 knots), the threshold required to transport sand (Butman, 1987). Samples with higher percentages of gravel (24-30% gravel) were found to the west and near the kettle hole depressions. Mud samples obtained by Bertoni (1974) were also near kettle holes in this area. Charting the reported locations show mud was taken from the edge of the kettle hole, with 'gravelly sediments' found a short distance away (approximately 600 feet). These results suggest complex flow patterns in the local vicinity of these bathymetric features. Some areas may experience strong scour

currents, stripping the bottom of fine-grained material, while adjacent areas may experience milder flow.

The closest sediment samples taken to Site 9 contained 99% sand and was located 1.5 nautical miles to the west, approximately at the same depth as Site 9. Figure 9 shows two bottom types west of Site 9: sand and silty sand. The lack of samples at Site 9 precludes further analysis.

Evidence presented from current observations as well as sediment samples suggests that bottom current regime at Site 8 is more variable than at Site 9. Bathymetric variability is greater in the Site 8 region than at Site 9, this variability will modify local currents and create complex flow patterns in and around features such as kettle holes, depressions, and/or ridges. Site 9, where bottom slopes are mild, is located in an area that may possess more consistent bottom currents.

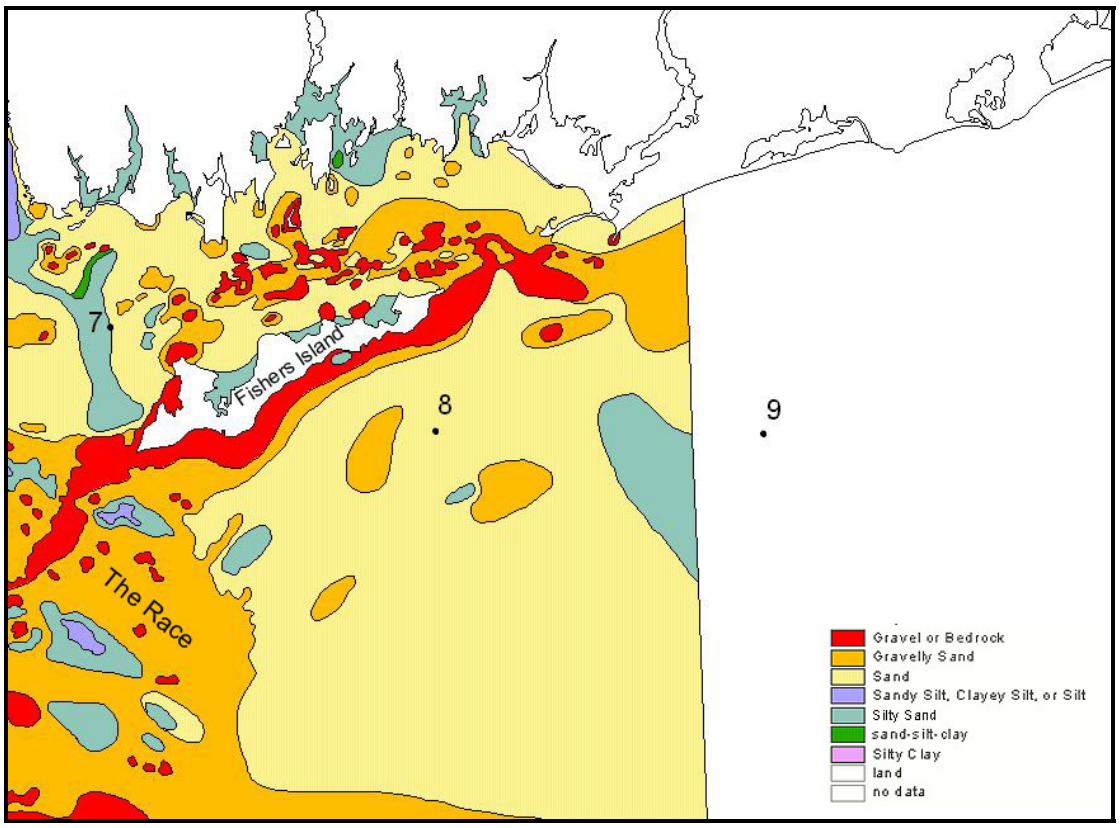

Figure 9. Map of surficial sediment types of northwestern Block Island Sound showing sites 8 and 9. Site 8 lies in a vast region of sand, while site 9 is likely in a region of silty sand. From United States Geological Survey Open File Report 00-304, Chapter 4.

References

Ayers, J.C., and Stockton, W.D., 1952. The Distribution of Salinity in the Waters of Long Island Sound, Block Island Sound, and Newport Bight, Cruise STIRNI-III, January-February 1952. Cornell University Status Report No. 21.

Bertoni, R.S., 1974. Geological and Geophysical Investigation of Block Island Sound between Fishers and Gardiners Islands. Storrs, University of Connecticut.

Bokuniewicz, H.J. and Gordon, R.B., 1980a. Sediment Transport and Deposition in Long Island Sound. Advances in Geophysics, 22.

Bokuniewicz, H.J.; and Gordon, R.B., 1980b. Storm and Tidal Energy in Long Island Sound. Advances in Geophysics, 22.

Bowman, Malcolm J, and Esaias, W. E., 1981. Fronts, Stratification, and Mixing in Long Island and Block Island Sounds. Journal of Geophysical Research, 86 (C5): 4260-4264.

Butman, B., 1987, Physical processes causing surficial-sediment movement, in Georges Bank, R.H. Backus [ed.], MIT Press, Chapter 13: 147-162.

Cook, G.S., 1966. Non-Tidal Circulation in Rhode Island Sound. Drift Bottle and Sea-Bed Drifter Experiments, 1962-1963. Naval Underwater Weapons Research and Engineering Station Technical Memorandum No. 369.

Dignes, T.W., 1976. Latest Quaternary benthic and foraminiferal paleoecology and sedimentary history of vibracores from Block Island Sound. M.S. Thesis, University of Rhode Island.

Driscoll, Neal, 1996. Scientists Study Large Storm and Human Effects in Block Island Sound. Oceanus Magazine, Spring/Summer 1996. Woods Hole Oceanographic Institution.

Freidrichs, C.T., and Aubrey, D.G. 1988. Non-linear Tidal Distortion in Shallow, Well-mixed Estuaries: A Synthesis. Estuarine, Coastal, and Shelf Science 26.

Gelfenbaum, G., and Stumpf, R.P., 1993. Observations of Currents and Density Structure Across a Buoyant Plume Front. Estuaries. Vol. 16, No. 1, p. 40-52.

Gordon, R.B., and Pillbeam, C.C., 1975. Circulation in central Long Island Sound. Journal of Geophysical Research. 80, 414-422.

Hicks, S.E., Frazier, D.E., Taylor, A.P, 1956. Wind Wave Characteristics of Rhode Island Waters. Narragansett Marine Laboratory, University of Rhode Island, Reference No. 56-3.

Hollman, R., Sandberg, G.R., 1972. The Residual Drift in Eastern Long Island Sound and Block Island Sound. New York State Science Laboratory Technical Report no. 0015. New York State Science Laboratory, Montauk, New York.

LeLacheur, E.A.,Sammons, J.C., 1932. Tides and Currents in Long Island and Block Island Sounds. United States Department of Commerce, Coast and Geodetic Survey, Special Publication 174.

Newman, W.S., and Fairbridge, R.W., 1960. Glacial lakes in Long Island Sound. The Geological Society of America, Abstracts with programs, 71:1936.

Noble, M., Butman, B., and Williams, E., 1983. On the Longshelf Structure and Dynamics of Subtidal Currents on the Eastern United States Continental Shelf. Journal of Physical Oceanography, 13 (12): 2125-2147.

Poppe, L. J., Knebel, H.J., Seekins, B.A., and Hastings, M. E., 2000. Map Showing the Distribution of Surficial Sediments in Long Island Sound. United States Geological Survey Open File Report 00-304, Chapter 4.

Rank, P.H., Grosch, C.E., Lukasik, S.J., Zepko, G.W., 1967. The Directional Swell Spectrum off Block Island. Stevens Institute of Technology, Davidson Laboratory Technical Report R-1155.

Redfield, A.C., 1950. The Analysis of Tidal Phenomena in Narrow Embayments. Papers in Physical Oceanography and Meteorology, 11.

Savard, W.L., 1966. The Sediments of Block Island Sound. Masters Thesis. University of Rhode Island.

Snooks, J.H., Jacobsen, J.P., 1979. Currents and Residual Drift in Block Island Sound During the Period February through December 1977. Technical Report. Yankee Atomic Electric Company, Environmental Sciences Group, Westborough, Massachusetts.

Swanson, C. and Spaulding, M., 1977. Nearshore Wave Climate for Block Island Sound. Technical Report Coastal Resources Center, University of Rhode Island.

Twitchell, D., 2001. Personal communication, Unpublished field notes of USGS vibracoring operations and analysis in 1973 (with John Dowling).

Williams, R.G., 1969a. Physical Oceanography of Block Island Sound. USL Report No. 966, Navy Underwater Sound Laboratory, Fort Trumbull, New London, Connecticut.

Williams, R.G., 1969b. The BIFI Oceanographic Program. United States Navy Underwater Sound Laboratory USL Technical Memorandum No. 2213-84-69. United States Navy Underwater Sound Laboratory, Fort Trumbull, New London, Connecticut.

Yokubaitis, Stephen K., 1977. Bed Forms as related to Sedimentary Processes in Block Island Sound, Rhode Island. Masters Thesis in Oceanography, University of Rhode Island.

NOPP (National Oceanic Partnership Program) website, 2001.
Link: http://www.nopp.uconn.edu/Science/ellipses.html

NOPP/CODAR (National Oceanic Partnership Program) website, 2001.
Link: http://www.nopp.uconn.edu/CODAR/index.html.

United States Department of Commerce, Coast and Geodetic Survey. 1958. Tidal Current Charts Long Island Sound and Block Island Sound.